

SEQUENCE LISTING

<110> MBARI

DeLong, Edward

Beja, Oded

<120> Light-driven energy generation using proteorhodopsin

<130> MBA-101

<150> 60/201,602

<151> 2000-05-03

<160> 65

<170> PatentIn version 3.0

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<212> DNA

<213> Naturally occurring gamma proteobacterium

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<221> CDS(complement)

<222> (50866)..(51615)

<223> light-driven proton pump; has the properties of a light-driven proton pump when expressed with retinal in Escherichia col

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<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T.,
Hadd,A.,Nguyen,L.P., Jovanovich,S.B., Gates,C.M.,
Feldman,R.A., DeLong,E.F

<302> Bacterial rhodopsin: evidence for a new type of phototrophy in the sea

<303> Science

<304> 289

<305> 5486

<306> 1902-1906

<307> 2000-09-15

<308> AF279106

<309> 2000-06-15

<313> (50866)..(51615)

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<222> (1)..(29)

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<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A.,
Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A., Spudich,J.L.,
Spudich,E.N. and DeLong,E.F.

<302> Bacterial rhodopsin: evidence for a new type of phototrophy in
the sea

<303> Science

<304> 289

<305> 5486

<306> 1902-1906

<307> 2000-09-15

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<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A.,
Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A., Spudich,J.L.,
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<302> Bacterial rhodopsin: evidence for a new type of phototrophy in
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<303> Science

<304> 289

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<306> 1902-1906

<307> 2000-09-15

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<213> Naturally occurring gamma proteobacterium

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<221> CDS

<222> (1)..(750)

<223> light-driven proton pump; has the properties of a light-driven proton pump when expressed with retinal in Escherichia coli. Note that additional three nucleotide residues incorporated by pcr priming with reference to the original 31A08 DNA sequence (DNA residues 4-6, ggt), adding a new restriction site for cloning

<300>

<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A.,Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A.,Spudich,J.L., Spudich,E.N. and DeLong,E.F

<302> Bacterial rhodopsin: evidence for a new type of phototrophy in the sea

<303> Science

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ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
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Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	
ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
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Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
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Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	
att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu	
100 105 110	
att ctt gct gct gca act aat gtt gct gga tca tta ttt aag aaa tta	384
Ile Leu Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu	
115 120 125	
cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca	432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala	
130 135 140	
gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg	480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp	
145 150 155 160	
gta tac atg att tat gaa tta tgg gct gga gaa gga aaa tct gca tgt	528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys	
165 170 175	
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Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr	
180 185 190	
att atc atc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt	624
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Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr	
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Ser	Phe	Trp	Leu	Val	Thr	Ala	Ala	Leu	Leu	Ala	Ser	Thr	Val	Phe	Phe	
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Arg	Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr	
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			100					105					110			

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 115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
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Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
 145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
 165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
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Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
 195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
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<212> DNA

<213> Naturally occurring gamma proteobacterium

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<221> CDS

<222> (1)..(747)

<223> Native proteorhodopsin DNA sequence from BAC clone 31A08

<300>

<301> Beja,O., Aravind,L., Koonin,E.V., Suzuki,M.T., Hadd,A.,
Nguyen,L.P., Jovanovich,S.B., Gates,C.M., Feldman,R.A., Spudich,J.L.,
Spudich,E.N. and DeLong,E.F.

<302> Bacterial rhodopsin: evidence for a new type of phototrophy in
the sea

<303> Science

<304> 289

<305> 5486

<306> 1902-1906

<307> 2000-09-15

<309> ____-__-__

<313> (1)..(747)

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gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt tct 96
Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val Ser
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ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc ttt 144
Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe Phe
35 40 45

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tct	ggt	ctt	gtt	act	ggt	att	gct	ttc	tgg	cat	tac	atg	tac	atg	aga	240
Ser	Gly	Leu	Val	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Met	Tyr	Met	Arg	
65					70					75					80	
ggg	gta	tgg	att	gaa	act	ggt	gat	tcg	cca	act	gta	ttt	aga	tac	att	288
Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr	Ile	
				85					90					95		
gat	tgg	tta	cta	aca	gtt	cct	cta	tta	ata	tgt	gaa	ttc	tac	tta	att	336
Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Leu	Ile	Cys	Glu	Phe	Tyr	Leu	Ile	
			100					105					110			
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Leu	Ala	Ala	Ala	Thr	Asn	Val	Ala	Gly	Ser	Leu	Phe	Lys	Lys	Leu	Leu	
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Val	Gly	Ser	Leu	Val	Met	Leu	Val	Phe	Gly	Tyr	Met	Gly	Glu	Ala	Gly	
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Tyr	Met	Ile	Tyr	Glu	Leu	Trp	Ala	Gly	Glu	Gly	Lys	Ser	Ala	Cys	Asn	
				165					170					175		
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Thr	Ala	Ser	Pro	Ala	Val	Gln	Ser	Ala	Tyr	Asn	Thr	Met	Met	Tyr	Ile	
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Ile	Ile	Phe	Gly	Trp	Ala	Ile	Tyr	Pro	Val	Gly	Tyr	Phe	Thr	Gly	Tyr	
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Leu	Met	Gly	Asp	Gly	Gly	Ser	Ala	Leu	Asn	Leu	Asn	Leu	Ile	Tyr	Asn	
	210					215				220						
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<213> Naturally occurring gamma proteobacterium

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Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr Val
50 55 60

Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met Arg
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Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr Ile
85 90 95

Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu Ile
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115 120 125

Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala Gly
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145 150 155 160

Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys Asn
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Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr Ile
180 185 190

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195 200 205

Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr Asn
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<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> proteorhodopsin variant from clone EBAC40

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Phe	Ala	Ala	Gly	Gly	Gly	Asp	Leu	Asp	Ala	Ser	Asp	Tyr	Thr	Gly	Val	
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Ser	Phe	Trp	Leu	Val	Thr	Ala	Ala	Leu	Leu	Ala	Ser	Thr	Val	Phe	Phe	
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Phe	Val	Glu	Arg	Asp	Arg	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr	
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65					70					75					80	

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Arg	Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr	
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Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Leu	Ile	Cys	Glu	Phe	Tyr	Leu	
			100					105					110			

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Gly	Ile	Met	Asn	Ala	Trp	Gly	Ala	Phe	Val	Ile	Gly	Cys	Leu	Ala	Trp	
145					150					155					160	

gta	tac	atg	att	tat	gaa	cta	tgg	gct	gga	gaa	ggc	aag	gct	gca	tgt	528
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Val	Tyr	Met	Ile	Tyr	Glu	Leu	Trp	Ala	Gly	Glu	Gly	Lys	Ala	Ala	Cys		
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			180					185					190				
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Ile	Ile	Ile	Phe	Gly	Trp	Ala	Ile	Tyr	Pro	Val	Gly	Tyr	Phe	Thr	Gly		
			195				200					205					
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Tyr	Leu	Met	Gly	Asp	Gly	Gly	Ser	Ala	Leu	Asn	Leu	Asn	Leu	Ile	Tyr		
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aat	gtt	gct	gtt	aaa	gaa	tct	tct	aat	gct							750	
Asn	Val	Ala	Val	Lys	Glu	Ser	Ser	Asn	Ala								
				245					250								

<210> 9

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 9

Met	Gly	Lys	Leu	Leu	Leu	Ile	Leu	Gly	Ser	Val	Ile	Ala	Leu	Pro	Thr
1				5					10					15	
Phe	Ala	Ala	Gly	Gly	Gly	Asp	Leu	Asp	Ala	Ser	Asp	Tyr	Thr	Gly	Val
			20					25					30		
Ser	Phe	Trp	Leu	Val	Thr	Ala	Ala	Leu	Leu	Ala	Ser	Thr	Val	Phe	Phe
		35					40					45			

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asp Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 10

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> proteorhodopsin variant from clone EBAC41

<400> 10

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	
ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	
tct ttt tgg tta gct act gct gct tta tta gca tct act gta ttt ttc	144
Ser Phe Trp Leu Ala Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	
ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	
gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg	240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
65 70 75 80	
aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	

att Ile	gat Asp	tgg Trp	tta Leu 100	cta Leu	aca Thr	gtt Val	cct Pro	cta Leu 105	tta Leu	ata Ile	tgt Cys	gaa Glu	ttc Phe 110	tac Tyr	tta Leu	336
att Ile	ctt Leu 115	gct Ala 115	gct Ala	gct Ala	act Thr	aat Asn	gtt Val 120	gct Ala	gga Gly	tca Ser	tta Leu	ttt Phe 125	aag Lys	aaa Lys	tta Leu	384
cta Leu 130	gtt Val	ggg Gly	tct Ser	ctt Leu	gtt Val	atg Met 135	ctt Leu	gtg Val	ttt Phe	ggg Gly	tac Tyr 140	atg Met	ggg Gly	gaa Glu	gca Ala	432
gga Gly 145	atc Ile	atg Met	gct Ala	gca Ala	tgg Trp 150	cct Pro	gca Ala	ttc Phe	att Ile	att Ile 155	ggg Gly	tgt Cys	tta Leu	gct Ala	tgg Trp 160	480
gta Val	tac Tyr	atg Met	att Ile	tat Tyr 165	gaa Glu	cta Leu	tgg Trp	gct Ala	gga Gly 170	gaa Glu	gga Gly	aaa Lys	tct Ser	gca Ala 175	tgt Cys	528
aat Asn	act Thr	gca Ala	agt Ser 180	cct Pro	gct Ala	gtg Val	caa Gln	tca Ser 185	gct Ala	tac Tyr	aac Asn	aca Thr	atg Met 190	atg Met	tat Tyr	576
att Ile	atc Ile 195	atc Ile	ttt Phe	ggg Gly	tgg Trp	gcg Ala	att Ile 200	tat Tyr	cct Pro	gta Val	ggg Gly	tat Tyr 205	ttc Phe	aca Thr	ggg Gly	624
tac Tyr 210	ctg Leu	atg Met	ggg Gly	gac Asp	ggg Gly	gga Gly 215	tca Ser	gct Ala	ctt Leu	aac Asn	tta Leu 220	aac Asn	ctt Leu	atc Ile	tat Tyr	672
aac Asn 225	ctt Leu	gct Ala	gat Asp	ttt Phe	gtt Val 230	aac Asn	aag Lys	att Ile	cta Leu	ttt Phe 235	ggg Gly	tta Leu	att Ile	ata Ile	tgg Trp 240	720
aat Asn	gtt Val	gct Ala	gtt Val	aaa Lys 245	gaa Glu	tct Ser	tct Ser	aat Asn	gct Ala 250							750

<210> 11

<213> Naturally occurring gamma proteobacterium

<400> 11

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Ala Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 12

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from clone EBAC64

<400> 12

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

48

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt

96

Phe	Ala	Ala	Gly 20	Gly	Gly	Asp	Leu	Asp 25	Ala	Ser	Asp	Tyr	Thr 30	Gly	Val	
tct	ttt	tgg	tta	gtt	aca	gct	gct	cta	tta	gca	tct	act	gta	ttt	ttc	144
Ser	Phe	Trp 35	Leu	Val	Thr	Ala	Ala	Leu	Leu	Ala	Ser	Thr 45	Val	Phe	Phe	
ttt	gtt	gaa	aga	gat	aga	gtt	tct	gca	aaa	tgg	aaa	aca	tca	tta	act	192
Phe	Val 50	Glu	Arg	Asp	Arg	Val 55	Ser	Ala	Lys	Trp	Lys 60	Thr	Ser	Leu	Thr	
gta	tct	ggt	ctt	gtt	act	ggg	att	gct	ttc	tgg	cat	tac	atg	tac	atg	240
Val 65	Ser	Gly	Leu	Val	Thr 70	Gly	Ile	Ala	Phe	Trp 75	His	Tyr	Met	Tyr	Met 80	
aga	gga	gta	tgg	att	gaa	act	ggg	gat	tcg	cct	act	gta	ttt	aga	tac	288
Arg	Gly	Val	Trp 85	Ile	Glu	Thr	Gly	Asp	Ser 90	Pro	Thr	Val	Phe	Arg 95	Tyr	
att	gat	tgg	tta	cta	aca	gtt	cct	tta	tta	ata	tgt	gaa	ttc	tac	tta	336
Ile	Asp	Trp 100	Leu	Leu	Thr	Val	Pro	Leu 105	Leu	Ile	Cys	Glu	Phe 110	Tyr	Leu	
att	ctt	gct	gct	gca	act	aat	gtt	gcc	ggc	tca	tta	ttt	aag	aaa	ctt	384
Ile	Leu	Ala 115	Ala	Ala	Thr	Asn	Val 120	Ala	Gly	Ser	Leu	Phe 125	Lys	Lys	Leu	
cta	gtt	ggt	tct	ctt	gtt	atg	ctt	gtg	ttt	ggg	tac	atg	ggg	gaa	gca	432
Leu 130	Val	Gly	Ser	Leu	Val	Met 135	Leu	Val	Phe	Gly	Tyr 140	Met	Gly	Glu	Ala	
gga	att	atg	gca	gct	tgg	cct	gca	ttc	att	att	ggg	tgt	tta	gct	tgg	480
Gly 145	Ile	Met	Ala	Ala	Trp 150	Pro	Ala	Phe	Ile	Ile 155	Gly	Cys	Leu	Ala	Trp 160	
gta	tac	atg	att	tat	gaa	cta	tat	gct	gga	gaa	gga	aaa	tct	gca	tgt	528
Val	Tyr	Met	Ile	Tyr 165	Glu	Leu	Tyr	Ala	Gly 170	Glu	Gly	Lys	Ser	Ala 175	Cys	
aat	act	gca	agt	cct	tcg	gtt	caa	tca	gct	tac	aac	aca	atg	atg	gct	576
Asn	Thr	Ala 180	Ser	Pro	Ser	Val	Gln	Ser 185	Ala	Tyr	Asn	Thr	Met 190	Met	Ala	
atc	ata	gtc	ttc	ggg	tgg	gca	att	tat	cct	ata	ggg	tat	ttc	aca	ggg	624
Ile	Ile	Val 195	Phe	Gly	Trp	Ala	Ile	Tyr	Pro	Ile	Gly	Tyr 205	Phe	Thr	Gly	
tac	cta	atg	ggg	gac	ggg	gga	tca	gct	ctt	aac	tta	aac	ctt	att	tat	672

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
 210 215 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg 720
 Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
 225 230 235 240

aat gtt gct gtt aaa gaa tct tct aat gct 750
 Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 13

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 13

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
 1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
 20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
 35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
 50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
 65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
 85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
180 185 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Ile Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 14

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone HOT01m: GenBank# AF349978

<400> 14

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	
ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	
tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc	144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	
ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	
gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg	240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
65 70 75 80	
aga ggg gta tgg att gag acc ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	
att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu	
100 105 110	
att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta	384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu	
115 120 125	
ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca	432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala	

130	135	140	
gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg			480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp			
145	150	155	160
gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt			528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys			
	165	170	175
aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat			576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr			
	180	185	190
ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt			624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly			
	195	200	205
tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat			672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr			
	210	215	220
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg			720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp			
	225	230	235
aat gtt gct gtt aaa gaa tct tct aat gct			750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala			
	245	250	

<210> 15

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 15

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val

30

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr

gta Val 65	tct Ser	ggt Gly	tta Leu	att Ile	act Thr 70	ggt Gly	ata Ile	gct Ala	ttt Phe 75	tgg Trp	cat His	tat Tyr	ctc Leu	tat Tyr	atg Met 80	240
aga Arg	ggt Gly	gtt Val	tgg Trp 85	ata Ile	gac Asp	act Thr	ggt Gly	gat Asp	acc Thr 90	cca Pro	aca Thr	gta Val	ttc Phe	aga Arg 95	tat Tyr	288
att Ile	gat Asp	tgg Trp 100	tta Leu	tta Leu	act Thr	gtt Val	cca Pro	tta Leu 105	caa Gln	atg Met	gtt Val	gag Glu	ttc Phe 110	tat Tyr	cta Leu	336
att Ile	ctt Leu	gct Ala 115	gct Ala	tgt Cys	aca Thr	agt Ser	gtt Val 120	gct Ala	gct Ala	tca Ser	tta Leu	ttt Phe 125	aag Lys	aag Lys	ctt Leu	384
cta Leu 130	gct Ala	ggt Gly	tca Ser	tta Leu	gta Val 135	atg Met	tta Leu	ggt Gly	gct Ala	gga Gly	ttt Phe 140	gca Ala	ggc Gly	gaa Glu	gct Ala	432
gga Gly 145	tta Leu	gct Ala	cct Pro	gta Val 150	tta Leu	cct Pro	gct Ala	ttc Phe	att Ile 155	att Ile	ggt Gly	atg Met	gct Ala	gga Gly	tgg Trp 160	480
tta Leu	tac Tyr	atg Met	att Ile 165	tat Tyr	gag Glu	cta Leu	tat Tyr	atg Met 170	ggt Gly	gaa Glu	ggt Gly	aag Lys	gct Ala	gct Ala 175	gta Val	528
agt Ser	act Thr	gca Ala 180	agt Ser	cct Pro	gct Ala	gtt Val	aac Asn	tct Ser 185	gca Ala	tac Tyr	aac Asn	gca Ala	atg Met 190	atg Met	atg Met	576
att Ile	att Ile	gtt Val 195	gtt Val	gga Gly	tgg Trp	gca Ala	att Ile 200	tat Tyr	cct Pro	gct Ala	gga Gly	tat Tyr 205	gct Ala	gct Ala	ggt Gly	624
tac Tyr 210	cta Leu	atg Met	ggt Gly	ggc Gly	gaa Glu	ggt Gly 215	gta Val	tac Tyr	gct Ala	tca Ser	aac Asn 220	tta Leu	aac Asn	ctt Leu	ata Ile	672
tat Tyr 225	aac Asn	ctt Leu	gcc Ala	gac Asp	ctt Leu 230	gtt Val	aac Asn	aag Lys	att Ile	cta Leu 235	ttt Phe	ggt Gly	ttg Leu	atc Ile	att Ile 240	720
tgg Trp	aat Asn	gtt Val	gct Ala	gtt Val 245	aaa Lys	gaa Glu	tct Ser	tct Ser	aat Asn 250	gct Ala						753

<210> 17

<211> 251

<212> PRT

<213> Naturally occurring gamma prtoeobacterium

<400> 17

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Ala
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 18

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone HOT75m3; GenBank#AF349980

<400> 18																
atg	ggt	aaa	tta	tta	ctg	ata	tta	ggt	agt	gct	att	gca	ctt	cca	tca	48
Met	Gly	Lys	Leu	Leu	Leu	Ile	Leu	Gly	Ser	Ala	Ile	Ala	Leu	Pro	Ser	
1			5			10			15							
ttt	gct	gct	gct	ggt	ggc	gat	cta	gat	ata	agt	gat	act	gtt	ggt	gtt	96
Phe	Ala	Ala	Ala	Gly	Gly	Asp	Leu	Asp	Ile	Ser	Asp	Thr	Val	Gly	Val	
20			25			30			35							
tca	ttc	tgg	ctg	gtt	aca	gct	ggg	atg	tta	gcg	gca	act	gta	ttc	ttt	144
Ser	Phe	Trp	Leu	Val	Thr	Ala	Gly	Met	Leu	Ala	Ala	Thr	Val	Phe	Phe	
35			40			45			50							
ttt	gta	gaa	aga	gac	caa	gtc	agc	gct	aag	tgg	aaa	act	tca	ctt	act	192
Phe	Val	Glu	Arg	Asp	Gln	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr	
50			55			60			65							
gta	tct	ggt	tta	att	act	ggg	ata	gct	ttt	tgg	cat	tat	ctc	tac	atg	240
Val	Ser	Gly	Leu	Ile	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Leu	Tyr	Met	
65			70			75			80							
aga	ggt	ggt	tgg	ata	gat	act	ggg	gat	aca	cca	aca	gta	ttt	aga	tat	288
Arg	Gly	Val	Trp	Ile	Asp	Thr	Gly	Asp	Thr	Pro	Thr	Val	Phe	Arg	Tyr	
85			90			95			100							
att	gat	tgg	tta	tta	act	ggt	cca	tta	caa	atg	ggt	gag	ttc	tat	cta	336
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Gln	Met	Val	Glu	Phe	Tyr	Leu	
100			105			110			115							
att	ctt	gct	gct	tgt	aca	agt	ggt	gct	gct	tca	tta	ttt	aag	aag	ctt	384
Ile	Leu	Ala	Ala	Cys	Thr	Ser	Val	Ala	Ala	Ser	Leu	Phe	Lys	Lys	Leu	
115			120			125			130							
cta	gct	ggg	tca	tta	gta	atg	tta	ggt	gct	gga	ttt	gca	ggc	gaa	gct	432
Leu	Ala	Gly	Ser	Leu	Val	Met	Leu	Gly	Ala	Gly	Phe	Ala	Gly	Glu	Ala	
130			135			140			145							
ggg	tta	gct	cct	gta	tta	cct	gct	ttc	att	att	ggg	atg	gct	gga	tgg	480
Gly	Leu	Ala	Pro	Val	Leu	Pro	Ala	Phe	Ile	Ile	Gly	Met	Ala	Gly	Trp	
145			150			155			160							
tta	tac	atg	att	tat	gag	cta	cat	atg	ggg	gaa	ggg	aag	gct	gct	gta	528
Leu	Tyr	Met	Ile	Tyr	Glu	Leu	His	Met	Gly	Glu	Gly	Lys	Ala	Ala	Val	
165			170			175			180							

FOF050"ETSL4860

agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg aag 576
 Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
 180 185 190

att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt 624
 Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
 195 200 205

tac cta atg agt ggt gac ggt gta tac gct tca aac tta aac ctt ata 672
 Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
 210 215 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att 720
 Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
 225 230 235 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct 753
 Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 19

<211> 251

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 19

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
 1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
 20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
 35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
 50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
180 185 190

Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 20
 <211> 753
 <212> DNA
 <213> Naturally occurring gamma proteobacterium

 <220>
 <221> CDS
 <222> (1)..(753)
 <223> Proteorhodopsin variant from pcr clone HOT75m4; GenBank #AF349981

<400> 20
 atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca 48
 Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
 1 5 10 15

 ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt 96
 Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
 20 25 30

 tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt 144
 Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
 35 40 45

 ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act 192
 Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
 50 55 60

 gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg 240
 Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
 65 70 75 80

 aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat 288
 Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
 85 90 95

 att gat tgg tta tta act gtt cca tta caa gtg gtt gag ttc tat cta 336
 Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu

att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt	384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu	
115 120 125	
cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct	432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala	
130 135 140	
gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg	480
Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp	
145 150 155 160	
tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta	528
Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val	
165 170 175	
agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg atg	576
Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met	
180 185 190	
att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt	624
Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly	
195 200 205	
tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata	672
Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile	
210 215 220	
tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att	720
Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile	
225 230 235 240	
tgg aat gtt gct gtt aaa gaa tct tct aat gct	753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala	
245 250	

<210> 21

<211> 251

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 21

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
 180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
 195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
 210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
 225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 22

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone HOT75m8: GenBank#AF349982

<400> 22

atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca 48
 Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
 1 5 10 15

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt 96
 Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val

20	25	30	
tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe 35 40 45			144
ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr 50 55 60			192
gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met 65 70 75 80			240
aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr 85 90 95			288
att gat tgg tta tta act gtt cca tta caa atg gtt gag ttc tat cta Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu 100 105 110			336
att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu 115 120 125			384
cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala 130 135 140			432
gga ttg gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp 145 150 155 160			480
tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val 165 170 175			528
agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg gtg Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val 180 185 190			576
att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly 195 200 205			624
tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctt ata Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile			672

210		215		220	
tat aac ctt gcc gac ctt gtt aac aag att cta ttt ggt ttg atc att					720
Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile					
225		230		235	240

tggaat gtt gct gtt aaa gaa tct tct aat gct					753
Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala					
	245		250		

<210> 23

<211> 251

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 23

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu

110

Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
180 185 190

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Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
      195                      200                      205

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Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 24

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB0m1: GenBank#AF349983

<400> 24

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Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	

tct ttt tgg tta gtt act gct gct cta tta gca tct act gta ttt ttc	144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg	240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
65 70 75 80	

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	

att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu	
100 105 110	

att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta	384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu	
115 120 125	

ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca	432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala	
130 135 140	

094450 "ETES" 050101

gga att atg aac gct tgg cct gca ttc att att ggg tgt tta gct tgg 480
 Gly Ile Met Asn Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
 145 150 155 160

gta tac atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt 528
 Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
 165 170 175

aat act gca agt cct tcg gtt caa tca gct tac aac aca atg atg gct 576
 Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
 180 185 190

atc ata gtc ttc ggt tgg gca att tat cct gta ggt tat ttc aca ggt 624
 Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
 195 200 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt att tat 672
 Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
 210 215 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg 720
 Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
 225 230 235 240

aat gtt gct gtt aaa gaa tct tct aat gct 750
 Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 25

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 25

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
 1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
 20 25 30

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
 225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 26

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB0m2

<400> 26

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc	144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg	240
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Val 65	Ser	Gly	Leu	Val 70	Thr	Gly	Ile	Ala	Phe	Trp 75	His	Tyr	Met	Tyr	Met 80	
aga	ggg	gta	tgg	att	gaa	act	ggt	gat	tcg	cca	act	gta	ttt	aga	tac	288
Arg	Gly	Val	Trp	Ile 85	Glu	Thr	Gly	Asp	Ser 90	Pro	Thr	Val	Phe	Arg	Tyr 95	
att	gat	tgg	tta	cta	aca	ggt	cct	cta	tta	ata	tgt	gaa	ttc	tac	tta	336
Ile	Asp	Trp	Leu 100	Leu	Thr	Val	Pro	Leu	Leu 105	Ile	Cys	Glu	Phe	Tyr	Leu	
att	ctt	gct	gct	gct	act	aat	ggt	gct	gct	ggc	ctg	ttt	aag	aaa	tta	384
Ile	Leu	Ala 115	Ala	Ala	Thr	Asn	Val 120	Ala	Ala	Gly	Leu	Phe 125	Lys	Lys	Leu	
ttg	ggt	ggg	tct	ctt	ggt	atg	ctt	gtg	ttt	ggt	tac	atg	ggg	gaa	gca	432
Leu	Val	Gly	Ser	Leu	Val	Met	Leu 135	Val	Phe	Gly	Tyr	Met	Gly	Glu	Ala	
gga	att	atg	aac	gct	tgg	ggg	gca	ttc	ggt	att	ggg	tgt	tta	gct	tgg	480
Gly	Ile	Met	Asn	Ala 145	Trp	Gly	Ala 150	Phe	Val	Ile 155	Gly	Cys	Leu	Ala	Trp 160	
gta	tac	atg	att	tat	gag	ctt	tgg	ctt	gga	gaa	gga	aaa	gct	gcg	tgt	528
Val	Tyr	Met	Ile	Tyr 165	Glu	Leu	Trp	Leu	Gly 170	Glu	Gly	Lys	Ala	Ala	Cys 175	
aat	aca	gca	agt	cct	gct	ggt	cag	tca	gct	tac	aac	aca	atg	atg	atg	576
Asn	Thr	Ala	Ser 180	Pro	Ala	Val	Gln	Ser	Ala 185	Tyr	Asn	Thr	Met	Met	Met	
atc	atc	atc	ttt	ggg	tgg	gca	att	tat	cct	gta	ggg	tat	ttc	aca	ggg	624
Ile	Ile	Ile	Phe 195	Gly	Trp	Ala	Ile 200	Tyr	Pro	Val	Gly	Tyr 205	Phe	Thr	Gly	
tac	cta	atg	ggg	gac	ggg	gga	tca	gca	ctt	aac	tta	aac	ctt	atc	tat	672
Tyr	Leu	Met	Gly	Asp	Gly	Gly	Ser 215	Ala	Leu	Asn	Leu 220	Asn	Leu	Ile	Tyr	
aac	ctt	gct	gac	ttt	ggt	aac	aag	att	cta	ttt	ggg	tta	att	ata	tgg	720
Asn	Leu	Ala	Asp	Phe 225	Val	Asn	Lys	Ile	Leu 230	Phe 235	Gly	Leu	Ile	Ile	Trp 240	
aat	ggt	gct	ggt	aaa	gaa	tct	tct	aat	gct							750
Asn	Val	Ala	Val	Lys 245	Glu	Ser	Ser	Asn	Ala 250							

<210> 27
 <211> 250
 <212> PRT
 <213> Naturally occurring gamma proteobacterium

<400> 27

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
 1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
 20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
 35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
 50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
 65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
 85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
 100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
 115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
 130 135 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Leu Gly Glu Gly Lys Ala Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Met
180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 28

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB20m2; GenBank #AF349985

[illegible]

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Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
 180 185 190

ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt 624
 Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
 195 200 205

tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat 672
 Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
 210 215 220

aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg 720
 Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
 225 230 235 240

aat gtt gct gtt aaa gaa tct tct aat gct 750
 Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 29

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 29

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
 1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
 20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
 35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
 50 55 60

Val	Ser	Gly	Leu	Val	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Met	Tyr	Met	65	70	75	80
Arg	Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr	85	90	95	
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Leu	Ile	Cys	Glu	Phe	Tyr	Leu	100	105	110	
Ile	Leu	Ala	Ala	Ala	Thr	Asn	Val	Ala	Ala	Gly	Leu	Phe	Lys	Lys	Leu	115	120	125	
Leu	Val	Gly	Ser	Leu	Val	Met	Leu	Val	Phe	Gly	Tyr	Met	Gly	Glu	Ala	130	135	140	
Gly	Ile	Met	Asn	Ala	Trp	Gly	Ala	Phe	Val	Ile	Gly	Cys	Leu	Ala	Trp	145	150	155	160
Val	Tyr	Met	Ile	Tyr	Glu	Leu	Trp	Ala	Gly	Glu	Gly	Lys	Ala	Ala	Cys	165	170	175	
Asn	Thr	Ala	Ser	Pro	Ala	Val	Gln	Ser	Ala	Tyr	Asn	Thr	Met	Met	Tyr	180	185	190	
Ile	Ile	Ile	Phe	Gly	Trp	Ala	Ile	Tyr	Pro	Val	Gly	Tyr	Phe	Thr	Gly	195	200	205	
Tyr	Leu	Met	Gly	Asp	Gly	Gly	Ser	Ala	Leu	Asn	Leu	Asn	Leu	Ile	Tyr	210	215	220	
Asn	Leu	Ala	Asp	Phe	Val	Asn	Lys	Ile	Leu	Phe	Gly	Leu	Ile	Ile	Trp	225	230	235	240
Asn	Val	Ala	Val	Lys	Glu	Ser	Ser	Asn	Ala							245	250		

<210> 30

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB20m5; GenBank#AF349986

10050"EF524860

<400> 30		
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Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr		
1 5 10 15		
ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt		96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val		
20 25 30		
tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc		144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe		
35 40 45		
ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act		192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr		
50 55 60		
gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg		240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met		
65 70 75 80		
aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac		288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr		
85 90 95		
att gat tgg tta cta aca gtt cct cta tta ata tgt gaa ttc tac tta		336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu		
100 105 110		

att Ile	ctt Leu	gct Ala 115	gct Ala	gct Ala	act Thr	aat Asn	gtt Val 120	gct Ala	gga Gly	tca Ser	tta Leu	ttt Phe 125	aag Lys	aaa Lys	tta Leu	384
cta Leu	gtt Val 130	ggt Gly	tct Ser	ctt Leu	gtt Val	atg Met 135	ctt Leu	gtg Val	ttt Phe	ggt Gly	tac Tyr 140	atg Met	ggt Gly	gaa Glu	gca Ala	432
caa Gln 145	att Ile	atg Met	gct Ala	gca Ala	tgg Trp 150	cct Pro	gca Ala	ttc Phe	att Ile	att Ile 155	ggg Gly	tgt Cys	tta Leu	gct Ala	tgg Trp 160	480
gta Val	tac Tyr	atg Met	att Ile	tat Tyr 165	gaa Glu	cta Leu	tat Tyr	gct Ala	gga Gly 170	gaa Glu	gga Gly	aaa Lys	tct Ser	gca Ala 175	tgt Cys	528
aat Asn	act Thr	gca Ala 180	agt Ser	cct Pro	tcg Ser	gtt Val	caa Gln	tca Ser 185	gct Ala	tac Tyr	aac Asn	aca Thr	atg Met 190	atg Met	gct Ala	576
atc Ile	ata Ile	gtc Val 195	ttc Phe	ggg Gly	tgg Trp	gca Ala	att Ile 200	tat Tyr	cct Pro	gta Val	ggg Gly	tat Tyr 205	ttc Phe	aca Thr	ggg Gly	624
tac Tyr	cta Leu 210	atg Met	ggg Gly	gac Asp	ggg Gly	ggg Gly 215	tca Ser	gct Ala	ctt Leu	aac Asn	tta Leu 220	aac Asn	ctt Leu	att Ile	tat Tyr	672
aac Asn 225	ctt Leu	gct Ala	gac Asp	ttt Phe	gtt Val 230	aac Asn	aag Lys	att Ile	cta Leu	ctt Leu 235	ggg Gly	tta Leu	att Ile	ata Ile	tgg Trp 240	720
aat Asn	gtt Val	gct Ala	gtt Val	aaa Lys 245	gaa Glu	tct Ser	tct Ser	aat Asn	gct Ala 250							750

<210> 31

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 31

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gln Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
180 185 190

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Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Leu Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 32

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB20m12; GenBank #AF349987

<400> 32

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt 96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc 144

Ser	Phe	Trp	Leu	Val	Thr	Ala	Ala	Leu	Leu	Ala	Ser	Thr	Val	Phe	Phe	
		35					40					45				
ttt	gtt	gaa	aga	gat	aga	gtt	tct	gca	aaa	tgg	aaa	aca	tca	tta	act	192
Phe	Val	Glu	Arg	Asp	Arg	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr	
	50					55					60					
gta	tct	ggg	ctt	gtt	act	ggg	att	gct	ttc	tgg	cat	tac	atg	tac	atg	240
Val	Ser	Gly	Leu	Val	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Met	Tyr	Met	
65					70					75					80	
aga	ggg	gta	tgg	att	gaa	act	ggg	gat	tcg	cca	act	gta	ttt	aga	tac	288
Arg	Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr	
				85					90					95		
att	gat	tgg	tta	cta	aca	gtt	cct	cta	tta	ata	tgt	gaa	ttc	tac	tta	336
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Leu	Ile	Cys	Glu	Phe	Tyr	Leu	
			100					105					110			
att	ctt	gct	gct	gca	gct	aat	gtt	gct	gga	tca	tta	ttt	aag	aaa	tta	384
Ile	Leu	Ala	Ala	Ala	Ala	Asn	Val	Ala	Gly	Ser	Leu	Phe	Lys	Lys	Leu	
		115					120					125				
cta	gtt	ggg	tct	ctt	gtt	atg	ctt	gtg	ttt	ggg	tac	atg	ggg	gaa	gca	432
Leu	Val	Gly	Ser	Leu	Val	Met	Leu	Val	Phe	Gly	Tyr	Met	Gly	Glu	Ala	
	130					135					140					
gga	atc	atg	gct	gca	tgg	cct	gca	ttc	att	att	ggg	tgt	tta	gct	tgg	480
Gly	Ile	Met	Ala	Ala	Trp	Pro	Ala	Phe	Ile	Ile	Gly	Cys	Leu	Ala	Trp	
145					150					155					160	
gta	tac	atg	att	tat	gaa	tta	tgg	gct	gga	gaa	gga	aaa	tct	gca	tgt	528
Val	Tyr	Met	Ile	Tyr	Glu	Leu	Trp	Ala	Gly	Glu	Gly	Lys	Ser	Ala	Cys	
				165					170					175		
aat	act	gca	agt	cct	gct	gtg	caa	tca	gcc	tac	aac	aca	atg	atg	tat	576
Asn	Thr	Ala	Ser	Pro	Ala	Val	Gln	Ser	Ala	Tyr	Asn	Thr	Met	Met	Tyr	
			180					185					190			
att	atc	atc	ttt	ggg	tgg	gcg	att	tat	cct	gta	ggg	tat	ttc	aca	ggg	624
Ile	Ile	Ile	Phe	Gly	Trp	Ala	Ile	Tyr	Pro	Val	Gly	Tyr	Phe	Thr	Gly	
		195					200					205				
tac	ttg	atg	ggg	gac	ggg	gga	tca	gct	ctt	aac	tta	aac	ctt	atc	tat	672
Tyr	Leu	Met	Gly	Asp	Gly	Gly	Ser	Ala	Leu	Asn	Leu	Asn	Leu	Ile	Tyr	
	210					215					220					
aac	ctt	gct	gac	ttt	gtt	aac	aag	att	cta	ttt	ggg	tta	att	ata	tgg	720

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
 225 230 235 240

aat gtt gct gtt aaa gaa tct tct aat gct
 Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

750

<210> 33

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 33

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
 1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
 20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
 35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
 50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
 65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
 85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
 100 105 110

09453-050101
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Ile Leu Ala Ala Ala Ala Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
 115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
 130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
 145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
 165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
 180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
 195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
 210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
 225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 34

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

145		150		155		160	
gta tat atg att tat gaa cta tat gct gga gaa gga aaa tct gca tgt							528
Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys							
		165		170		175	
aat aca gca agt cct gct gtg caa tca gct tac aac aca atg atg tat							576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr							
		180		185		190	
att atc gtc ttt ggt tgg gcg att tat cct gta ggt tat ttc aca ggt							624
Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly							
		195		200		205	
tac ctg atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat							672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr							
		210		215		220	
aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg							720
Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp							
		225		230		235	240
aat gtt gct gtt aaa gaa tct tct aat gct							750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala							
		245		250			
<210>	35						
<211>	250						
<212>	PRT						
<213>	Naturally occurring gamma proteobacterium						
<400>	35						
Met Gly Lys Leu Leu Leu Ile Ile Gly Ser Val Ile Ala Leu Pro Thr							
1		5		10		15	
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val							
	20		25		30		
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe							

35

40

45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp

240

<213> Naturally occurring gamma proteobacterium

<223> Proteorhodopsin variant from pcr clone MB40m5;p GenBank #AF349989

gta tcg ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg 240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

aga ggg gta tgg att gag act ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	
att gat tgg tta cta aca gtt cct cta ttg ata tgt gaa ttc tac tta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu	
100 105 110	
att ctt gct gct gca aca aat gtt gct gct ggc ctg ttt aag aaa tta	384
Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu	
115 120 125	
ttg gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gag gca	432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala	
130 135 140	
gga att atg aac gct tgg ggt gca ttc gtt att ggg tgt tta gct tgg	480
Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp	
145 150 155 160	
gta tac atg att tat gaa cta tgg gct gga gaa ggc aag gct gca tgt	528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys	
165 170 175	
aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat	576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr	
180 185 190	
ata atc atc ttt ggt tgg gca att tat cct gta ggt tat ttc aca ggt	624
Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly	
195 200 205	
tac cta atg ggt gac ggt gga tca gct ctt aac tta aac ctt atc tat	672
Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr	
210 215 220	
aac ctt gct gac ttt gtt aac aag aat cta ttt ggt tta att ata tgg	720
Asn Leu Ala Asp Phe Val Asn Lys Asn Leu Phe Gly Leu Ile Ile Trp	
225 230 235 240	
aat gtt gct gtt aaa gaa tct tct aat gct	750
Asn Val Ala Val Lys Glu Ser Ser Asn Ala	
245 250	

<210> 37

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 37

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Ala Gly Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Asn Ala Trp Gly Ala Phe Val Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ala Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Asn Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 38

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB40m12; GenBank # AF34999

<400> 38

atg ggt aaa tta tta cgg ata tta ggt agt gtt att gca ctt cct aca	48
Met Gly Lys Leu Leu Arg Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	
ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	
tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc	144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	
ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	
gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg	240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
65 70 75 80	
aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	
att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu	
100 105 110	
att ctt gct gct gca act aat gtt gct gga tca tta ttt aag aaa tta	384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu	
115 120 125	
cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca	432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala	
130 135 140	
gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg	480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp	
145 150 155 160	
gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt	528
Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys	
165 170 175	
aat act gca agt cct gct gtg caa tca gct tac aac aca atg atg tat	576
Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr	
180 185 190	

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 40

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB100m5; GenBank #AF349991

<400> 40

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	
ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	
tct ttt tgg tta gtt aca gct gct cta tta gca tct act gta ttt ttc	144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	
ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	
gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tac atg	240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
65 70 75 80	
aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	
att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu	
100 105 110	
att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt	384

Ile	Leu	Ala	Ala	Ala	Thr	Asn	Val	Ala	Gly	Ser	Leu	Phe	Lys	Lys	Leu		
		115					120					125					
cta	gtt	ggg	tct	ctt	gtt	atg	ctt	gtg	ttt	ggg	tac	atg	ggg	gaa	gca		432
Leu	Val	Gly	Ser	Leu	Val	Met	Leu	Val	Phe	Gly	Tyr	Met	Gly	Glu	Ala		
		130				135					140						
gga	att	atg	gca	gct	tgg	cct	gca	ttc	att	att	ggg	tgt	tta	gct	tgg		480
Gly	Ile	Met	Ala	Ala	Trp	Pro	Ala	Phe	Ile	Ile	Gly	Cys	Leu	Ala	Trp		
		145			150					155					160		
gta	tac	atg	att	tat	gaa	cta	tat	gct	gga	gaa	gga	aaa	tct	gca	tgt		528
Val	Tyr	Met	Ile	Tyr	Glu	Leu	Tyr	Ala	Gly	Glu	Gly	Lys	Ser	Ala	Cys		
				165					170					175			
aat	act	gca	agt	cct	tcg	gtt	caa	tca	gct	tac	aac	aca	atg	atg	gct		576
Asn	Thr	Ala	Ser	Pro	Ser	Val	Gln	Ser	Ala	Tyr	Asn	Thr	Met	Met	Ala		
			180				185						190				
atc	ata	gtc	ttc	ggg	tgg	gca	att	tat	cct	gta	ggg	tat	ttc	aca	ggg		624
Ile	Ile	Val	Phe	Gly	Trp	Ala	Ile	Tyr	Pro	Val	Gly	Tyr	Phe	Thr	Gly		
		195					200					205					
tac	cta	atg	ggg	gac	ggg	gga	tca	gct	ctt	aac	tta	aac	ctt	att	tat		672
Tyr	Leu	Met	Gly	Asp	Gly	Gly	Ser	Ala	Leu	Asn	Leu	Asn	Leu	Ile	Tyr		
		210				215					220						
aac	ctt	gct	gac	ttt	gtt	aac	aag	att	cta	ttt	ggg	tta	att	ata	tgg		720
Asn	Leu	Ala	Asp	Phe	Val	Asn	Lys	Ile	Leu	Phe	Gly	Leu	Ile	Ile	Trp		
		225			230					235					240		
aat	gtt	gct	gtt	aaa	gaa	tct	tct	aat	gct								750
Asn	Val	Ala	Val	Lys	Glu	Ser	Ser	Asn	Ala								
				245					250								

<210> 41

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 41

Met	Gly	Lys	Leu	Leu	Leu	Ile	Leu	Gly	Ser	Val	Ile	Ala	Leu	Pro	Thr	1	5	10	15
Phe	Ala	Ala	Gly	Gly	Gly	Asp	Leu	Asp	Ala	Ser	Asp	Tyr	Thr	Gly	Val	20	25	30	
Ser	Phe	Trp	Leu	Val	Thr	Ala	Ala	Leu	Leu	Ala	Ser	Thr	Val	Phe	Phe	35	40	45	
Phe	Val	Glu	Arg	Asp	Arg	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr	50	55	60	
Val	Ser	Gly	Leu	Val	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Met	Tyr	Met	65	70	75	80
Arg	Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr	85	90	95	
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Leu	Ile	Cys	Glu	Phe	Tyr	Leu	100	105	110	
Ile	Leu	Ala	Ala	Ala	Thr	Asn	Val	Ala	Gly	Ser	Leu	Phe	Lys	Lys	Leu	115	120	125	
Leu	Val	Gly	Ser	Leu	Val	Met	Leu	Val	Phe	Gly	Tyr	Met	Gly	Glu	Ala	130	135	140	
Gly	Ile	Met	Ala	Ala	Trp	Pro	Ala	Phe	Ile	Ile	Gly	Cys	Leu	Ala	Trp	145	150	155	160
Val	Tyr	Met	Ile	Tyr	Glu	Leu	Tyr	Ala	Gly	Glu	Gly	Lys	Ser	Ala	Cys	165	170	175	
Asn	Thr	Ala	Ser	Pro	Ser	Val	Gln	Ser	Ala	Tyr	Asn	Thr	Met	Met	Ala	180	185	190	

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
 195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
 210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
 225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 42

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB100m7; GenBank #AF349992

<400> 42

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca 48
 Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
 1 5 10 15

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt 96
 Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
 20 25 30

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc 144
 Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
 35 40 45

ttt Phe 50	ggt Val	gaa Glu	aga Arg	gat Asp	aga Arg	ggt Val 55	tct Ser	gca Ala	aaa Lys	tgg Trp 60	aaa Lys	aca Thr	tca Ser	tta Leu	act Thr	192
gta Val 65	tct Ser	ggt Gly	ctt Leu	ggt Val	act Thr 70	ggt Gly	att Ile	gct Ala	ttc Phe	tgg Trp 75	cat His	tac Tyr	atg Met	tac Tyr	atg Met 80	240
aga Arg	ggg Gly	gta Val	tgg Trp	att Ile 85	gaa Glu	act Thr	ggt Gly	gat Asp	tcg Ser 90	cca Pro	act Thr	gta Val	ttt Phe	aga Arg 95	tac Tyr	288
att Ile	gat Asp	tgg Trp	tta Leu 100	cta Leu	aca Thr	ggt Val	cct Pro	cta Leu 105	tta Leu	ata Ile	tgt Cys	gaa Glu	ttc Phe 110	tac Tyr	tta Leu	336
att Ile	ctt Leu	gct Ala 115	gct Ala	gct Ala	act Thr	aat Asn 120	ggt Val	gcc Ala	ggc Gly	tca Ser	tta Leu	ttt Phe 125	aag Lys	aaa Lys	ctt Leu	384
cta Leu 130	ggt Val	ggt Gly	tct Ser	ctt Leu	ggt Val	atg Met 135	ctt Leu	gtg Val	ttt Phe	ggt Gly	tac Tyr 140	atg Met	ggt Gly	gaa Glu	gca Ala	432
gga Gly 145	att Ile	atg Met	gca Ala	gct Ala	tgg Trp 150	cct Pro	gca Ala	ttc Phe	att Ile	att Ile 155	ggg Gly	tgt Cys	tta Leu	gct Ala	tgg Trp 160	480
gta Val	tac Tyr	atg Met	att Ile	tat Tyr 165	gaa Glu	cta Leu	tat Tyr	gct Ala	gga Gly 170	gaa Glu	gga Gly	aaa Lys	tct Ser	gca Ala 175	tgt Cys	528
aat Asn	act Thr	gca Ala	agt Ser	cct Pro	tcg Ser	ggt Val	caa Gln	tca Ser 185	gct Ala	tac Tyr	aac Asn	aca Thr	atg Met 190	atg Met	gct Ala	576
atc Ile	ata Ile	gtc Val 195	ttc Phe	ggt Gly	tgg Trp	gca Ala	att Ile 200	tat Tyr	cct Pro	gta Val	ggt Gly	tat Tyr 205	ttc Phe	aca Thr	ggt Gly	624
tac Tyr 210	cta Leu	atg Met	ggt Gly	gac Asp	ggt Gly	gga Gly 215	tca Ser	gct Ala	ctt Leu	aac Asn	tta Leu 220	aac Asn	ctt Leu	att Ile	tat Tyr	672
aac Asn 225	ctt Leu	gct Ala	gac Asp	ttt Phe	ggt Val 230	aac Asn	aag Lys	att Ile	cta Leu	ttt Phe 235	ggt Gly	tta Leu	att Ile	ata Ile	tgg Trp 240	720

aat gct gct gtt aaa gaa tct tct aat gct
 Asn Ala Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 43

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 43

Met	Gly	Lys	Leu	Leu	Leu	Ile	Leu	Gly	Ser	Val	Ile	Ala	Leu	Pro	Thr
1				5					10					15	
Phe	Ala	Ala	Gly	Gly	Gly	Asp	Leu	Asp	Ala	Ser	Asp	Tyr	Thr	Gly	Val
			20					25					30		
Ser	Phe	Trp	Leu	Val	Thr	Ala	Ala	Leu	Leu	Ala	Ser	Thr	Val	Phe	Phe
		35					40					45			
Phe	Val	Glu	Arg	Asp	Arg	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr
	50					55					60				
Val	Ser	Gly	Leu	Val	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Met	Tyr	Met
65					70					75				80	
Arg	Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr
				85					90					95	
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Leu	Ile	Cys	Glu	Phe	Tyr	Leu
			100					105					110		
Ile	Leu	Ala	Ala	Ala	Thr	Asn	Val	Ala	Gly	Ser	Leu	Phe	Lys	Lys	Leu
		115					120					125			

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Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp
145 150 155 160

Val Tyr Met Ile Tyr Glu Leu Tyr Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ser Val Gln Ser Ala Tyr Asn Thr Met Met Ala
180 185 190

Ile Ile Val Phe Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Ala Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 44

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB100m9; GenBank #AF349993

<400> 44

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	

ttt gct gca ggt ggt ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	

tct ttt tgg tta gtt act gct gct tta tta gca tct act gta ttt ttc	144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg	240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
65 70 75 80	

aga ggg gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	
85 90 95	

ata gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu	
100 105 110	

att ctt gcc gct gca act aat gtt gct gga tca tta ttt aag aaa tta	384
Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu	
115 120 125	

ctt gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca	432
Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala	
130 135 140	

gga atc atg gct gca tgg cct gca ttc att att ggg tgt tta gct tgg	480
Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Ile Gly Cys Leu Ala Trp	
145 150 155 160	

gta tac atg att tat gaa cta tgg gct gga gaa gga aaa tct gca tgt	528
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Phe	Val	Glu	Arg	Asp	Arg	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr	
50						55					60					
Val	Ser	Gly	Leu	Val	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Met	Tyr	Met	
65					70					75					80	
Arg	Gly	Val	Trp	Ile	Glu	Thr	Gly	Asp	Ser	Pro	Thr	Val	Phe	Arg	Tyr	
				85					90					95		
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Leu	Ile	Cys	Glu	Phe	Tyr	Leu	
			100					105					110			
Ile	Leu	Ala	Ala	Ala	Thr	Asn	Val	Ala	Gly	Ser	Leu	Phe	Lys	Lys	Leu	
		115					120					125				
Leu	Val	Gly	Ser	Leu	Val	Met	Leu	Val	Phe	Gly	Tyr	Met	Gly	Glu	Ala	
		130				135					140					
Gly	Ile	Met	Ala	Ala	Trp	Pro	Ala	Phe	Ile	Ile	Gly	Cys	Leu	Ala	Trp	
145					150					155					160	
Val	Tyr	Met	Ile	Tyr	Glu	Leu	Trp	Ala	Gly	Glu	Gly	Lys	Ser	Ala	Cys	
				165					170					175		
Asn	Thr	Ala	Ser	Pro	Ala	Val	Gln	Ser	Ala	Tyr	Asn	Thr	Met	Met	Tyr	
			180					185					190			
Ile	Ile	Ile	Phe	Gly	Trp	Ala	Ile	Tyr	Pro	Val	Gly	Tyr	Phe	Thr	Gly	
		195					200					205				
Tyr	Leu	Met	Gly	Asp	Gly	Gly	Ser	Ala	Leu	Asn	Leu	Asn	Leu	Ile	Tyr	
	210					215					220					
Asn	Leu	Ala	Asp	Phe	Val	Asn	Lys	Ile	Leu	Phe	Gly	Leu	Ile	Ile	Trp	
225					230					235					240	

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 46

<211> 750

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(750)

<223> Proteorhodopsin variant from pcr clone MB100m10; GenBank #AF34999

<400> 46

atg ggt aaa tta tta ctg ata tta ggt agt gtt att gca ctt cct aca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr	
1 5 10 15	

ttt gct gca ggt ggc ggt gac ctt gat gct agt gat tac act ggt gtt	96
Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val	
20 25 30	

tct ttt tgg tta gtt aca gct gct cta tta gcg tct act gta ttt ttc	144
Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe	
35 40 45	

ttt gtt gaa aga gat aga gtt tct gca aaa tgg aaa aca tca tta act	192
Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	

gta tct ggt ctt gtt act ggt att gct ttc tgg cat tac atg tat atg	240
Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met	
65 70 75 80	

aga gga gta tgg att gaa act ggt gat tcg cca act gta ttt aga tac	288
Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr	

	85	90	95	
	att gat tgg tta cta aca gtt cct tta tta ata tgt gaa ttc tac tta			336
	Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu			
	100	105	110	
	att ctt gct gct gca act aat gtt gcc ggc tca tta ttt aag aaa ctt			384
	Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu			
	115	120	125	
	cta gtt ggt tct ctt gtt atg ctt gtg ttt ggt tac atg ggt gaa gca			432
	Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala			
	130	135	140	
	gga ata atg gcg gct tgg cct gca ttc atc gtt gga tgt tta gca tgg			480
	Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Val Gly Cys Leu Ala Trp			
	145	150	155	160
	gta tat atg att tat gaa cta tgg gct ggt gaa gga aaa tct gca tgt			528
	Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys			
	165	170	175	
	aat act gca agt cct gct gta cag tca gct tac aac aca atg atg tat			576
	Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr			
	180	185	190	
	atc atc atc gtt ggt tgg gca att tat cct gta ggt tat ttc aca ggt			624
	Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly			
	195	200	205	
	tac cta atg ggt gac ggt gga tca gct ctt aat cta aac ctt att tat			672
	Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr			
	210	215	220	
	aac ctt gct gac ttt gtt aac aag att cta ttt ggt tta att ata tgg			720
	Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp			
	225	230	235	240
	aat gtt gct gtt aaa gaa tct tct aat gct			750
	Asn Val Ala Val Lys Glu Ser Ser Asn Ala			
	245	250		

<210> 47

<211> 250

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 47

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Val Ile Ala Leu Pro Thr
1 5 10 15

Phe Ala Ala Gly Gly Gly Asp Leu Asp Ala Ser Asp Tyr Thr Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Ala Leu Leu Ala Ser Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Arg Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Val Thr Gly Ile Ala Phe Trp His Tyr Met Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Glu Thr Gly Asp Ser Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Leu Ile Cys Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Ala Thr Asn Val Ala Gly Ser Leu Phe Lys Lys Leu
115 120 125

Leu Val Gly Ser Leu Val Met Leu Val Phe Gly Tyr Met Gly Glu Ala
130 135 140

Gly Ile Met Ala Ala Trp Pro Ala Phe Ile Val Gly Cys Leu Ala Trp
145 150 155 160

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Val Tyr Met Ile Tyr Glu Leu Trp Ala Gly Glu Gly Lys Ser Ala Cys
165 170 175

Asn Thr Ala Ser Pro Ala Val Gln Ser Ala Tyr Asn Thr Met Met Tyr
180 185 190

Ile Ile Ile Val Gly Trp Ala Ile Tyr Pro Val Gly Tyr Phe Thr Gly
195 200 205

Tyr Leu Met Gly Asp Gly Gly Ser Ala Leu Asn Leu Asn Leu Ile Tyr
210 215 220

Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile Trp
225 230 235 240

Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 48

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PALB1; GenBank #AF349995

<400> 48

atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

48

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val	96
20 25 30	
tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe	144
35 40 45	
ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	192
50 55 60	
gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met	240
65 70 75 80	
aga ggt gtt tgg ata gat act ggt gat aca cca aca gta ttt aga tat Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr	288
85 90 95	
att gat tgg cta tta act gtt cca tta caa atg gtt gag ttc tat cta Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu	336
100 105 110	
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu	384
115 120 125	
cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala	432
130 135 140	
ggt tta gct cct gta tta cct gct ttc att ctt ggt atg gct ggt tgg Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Leu Gly Met Ala Gly Trp	480
145 150 155 160	
tta tac atg att tat gag cta cat atg ggt gaa ggt aag gct gct gta Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val	528
165 170 175	
agt act gca agt cct gct gtt aac tct gct tac aat gca atg atg aag Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys	576
180 185 190	
att att gtt att gga tgg gca att tat cct gct gga tat gct gct ggt Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly	624
195 200 205	

tac	cta	atg	agt	ggg	gac	ggg	gta	tac	gct	tca	aac	tta	aac	ctt	ata	672
Tyr	Leu	Met	Ser	Gly	Asp	Gly	Val	Tyr	Ala	Ser	Asn	Leu	Asn	Leu	Ile	
	210					215					220					

tat	aac	ctt	gct	gac	ttt	gtt	aac	aag	att	cta	ttt	ggg	ttg	atc	att	720
Tyr	Asn	Leu	Ala	Asp	Phe	Val	Asn	Lys	Ile	Leu	Phe	Gly	Leu	Ile	Ile	
225					230					235					240	

tgg	aat	gtt	gct	gtt	aaa	gaa	tct	tct	aat	gct						753
Trp	Asn	Val	Ala	Val	Lys	Glu	Ser	Ser	Asn	Ala						
				245					250							

<210> 49

<211> 251

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 49

Met	Gly	Lys	Leu	Leu	Leu	Ile	Leu	Gly	Ser	Ala	Ile	Ala	Leu	Pro	Ser
1				5					10					15	

Phe	Ala	Ala	Ala	Gly	Gly	Asp	Leu	Asp	Ile	Ser	Asp	Thr	Val	Gly	Val
			20					25					30		

Ser	Phe	Trp	Leu	Val	Thr	Ala	Gly	Met	Leu	Ala	Ala	Thr	Val	Phe	Phe
		35					40					45			

Phe	Val	Glu	Arg	Asp	Gln	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr
	50					55					60				

Val	Ser	Gly	Leu	Ile	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Leu	Tyr	Met
65					70					75					80

Arg	Gly	Val	Trp	Ile	Asp	Thr	Gly	Asp	Thr	Pro	Thr	Val	Phe	Arg	Tyr
				85					90					95	

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PALB2; GenBank #AF349996

<400> 50

atg	ggt	aaa	tta	tta	ctg	ata	tta	ggt	agt	gct	att	gca	ctt	cca	tca	48
Met	Gly	Lys	Leu	Leu	Leu	Ile	Leu	Gly	Ser	Ala	Ile	Ala	Leu	Pro	Ser	
1				5					10					15		

ttt	gct	gct	gct	ggt	ggc	gat	cta	gat	ata	agt	gat	act	gtt	ggt	gtt	96
Phe	Ala	Ala	Ala	Gly	Gly	Asp	Leu	Asp	Ile	Ser	Asp	Thr	Val	Gly	Val	
			20					25					30			

tca	ttc	tgg	ctg	gtt	aca	gct	ggt	atg	tta	gcg	gca	act	gtg	ttc	ttt	144
Ser	Phe	Trp	Leu	Val	Thr	Ala	Gly	Met	Leu	Ala	Ala	Thr	Val	Phe	Phe	
		35					40					45				

ttt	gta	gaa	aga	gac	caa	gtc	agc	gct	gag	tgg	aaa	act	tca	ctt	act	192
Phe	Val	Glu	Arg	Asp	Gln	Val	Ser	Ala	Glu	Trp	Lys	Thr	Ser	Leu	Thr	
	50					55					60					

gta	tct	ggt	tta	att	act	ggt	ata	gct	ttt	tgg	cat	tat	ctc	tat	atg	240
Val	Ser	Gly	Leu	Ile	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Leu	Tyr	Met	
65					70					75					80	

aga	ggt	gtt	tgg	ata	gat	act	ggt	gat	acc	cca	aca	gta	ttc	aga	tat	288
Arg	Gly	Val	Trp	Ile	Asp	Thr	Gly	Asp	Thr	Pro	Thr	Val	Phe	Arg	Tyr	
				85				90						95		

att	gat	tgg	tta	tta	act	gtt	cca	tta	caa	atg	gtt	gag	ttc	tat	cta	336
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Gln	Met	Val	Glu	Phe	Tyr	Leu	
			100					105					110			

att	ctt	gct	gct	tgt	aca	agt	gtt	gct	gct	tca	tta	ttt	aag	aag	ctt	384
Ile	Leu	Ala	Ala	Cys	Thr	Ser	Val	Ala	Ala	Ser	Leu	Phe	Lys	Lys	Leu	
		115					120					125				

cta	gct	ggt	tca	tta	gta	atg	tta	ggt	gct	gga	ttt	gca	ggc	gaa	gct	432
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Leu	Ala	Gly	Ser	Leu	Val	Met	Leu	Gly	Ala	Gly	Phe	Ala	Gly	Glu	Ala		
130						135					140						
gga	tta	gct	cct	gta	tta	cct	gct	ttc	att	att	ggt	atg	gct	gga	tgg	480	
Gly	Leu	Ala	Pro	Val	Leu	Pro	Ala	Phe	Ile	Ile	Gly	Met	Ala	Gly	Trp		
145					150					155					160		
tta	tac	atg	att	tat	gag	cta	tat	atg	ggt	gaa	ggt	aag	gct	gct	gta	528	
Leu	Tyr	Met	Ile	Tyr	Glu	Leu	Tyr	Met	Gly	Glu	Gly	Lys	Ala	Ala	Val		
				165					170					175			
agt	act	gca	agt	cct	gct	ggt	aac	tct	gca	tac	aac	gca	atg	atg	atg	576	
Ser	Thr	Ala	Ser	Pro	Ala	Val	Asn	Ser	Ala	Tyr	Asn	Ala	Met	Met	Met		
			180					185					190				
att	att	gtt	gtt	gga	tgg	gca	att	tat	cct	gct	gga	tat	gct	gct	ggt	624	
Ile	Ile	Val	Val	Gly	Trp	Ala	Ile	Tyr	Pro	Ala	Gly	Tyr	Ala	Ala	Gly		
		195					200					205					
tac	cta	atg	ggt	ggc	gaa	ggt	gta	tac	gct	tca	aac	tta	aac	ctt	ata	672	
Tyr	Leu	Met	Gly	Gly	Glu	Gly	Val	Tyr	Ala	Ser	Asn	Leu	Asn	Leu	Ile		
		210				215					220						
tat	aac	ctt	gct	gac	ttt	ggt	aac	aag	att	cta	ttt	ggt	ttg	atc	att	720	
Tyr	Asn	Leu	Ala	Asp	Phe	Val	Asn	Lys	Ile	Leu	Phe	Gly	Leu	Ile	Ile		
225					230					235					240		
tgg	aat	gtt	gct	ggt	aaa	gaa	tct	tct	aat	gct						753	
Trp	Asn	Val	Ala	Val	Lys	Glu	Ser	Ser	Asn	Ala							
				245					250								
<210>	51																
<211>	251																
<212>	PRT																
<213>	Naturally occurring gamma proteobacterium																
<400>	51																
Met	Gly	Lys	Leu	Leu	Leu	Ile	Leu	Gly	Ser	Ala	Ile	Ala	Leu	Pro	Ser		
1				5					10					15			

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Glu Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
 210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
 225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 52

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PALB5; GenBank#AF349997

<400> 52

atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser	
1 5 10 15	

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt	96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val	
20 25 30	

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt	144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe	
35 40 45	

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act	192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	

gta Val 65	tct Ser	ggg Gly	tta Leu	att Ile	act Thr 70	ggg Gly	ata Ile	gcc Ala	ttt Phe 75	tgg Trp	cat His	tat Tyr	ctc Leu	tat Tyr	atg Met 80	240
aga Arg	ggg Gly	gtt Val	tgg Trp 85	ata Ile	gac Asp	act Thr	ggg Gly	gat Asp	acc Thr 90	cca Pro	aca Thr	gta Val	ttc Phe	aga Arg 95	tat Tyr	288
att Ile	gat Asp	tgg Trp 100	tta Leu	tta Leu	act Thr	gtt Val	cca Pro	tta Leu 105	caa Gln	atg Met	gtt Val	gag Glu	ttc Phe 110	tat Tyr	cta Leu	336
att Ile	ctt Leu	gct Ala 115	gct Ala	tgt Cys	aca Thr	aat Asn	gtt Val 120	gct Ala	gct Ala	tca Ser	tta Leu	ttt Phe 125	aag Lys	aag Lys	ctt Leu	384
cta Leu 130	gct Ala	ggg Gly	tca Ser	tta Leu	gta Val	atg Met 135	tta Leu	ggg Gly	gct Ala	gga Gly	ttt Phe 140	gca Ala	ggc Gly	gaa Glu	gct Ala	432
gga Gly 145	tta Leu	gct Ala	cct Pro	gta Val	tgg Trp 150	cct Pro	gct Ala	ttc Phe	att Ile 155	att Ile	ggg Gly	atg Met	gct Ala	gga Gly	tgg Trp 160	480
tta Leu	tac Tyr	atg Met	att Ile 165	tat Tyr	gag Glu	cta Leu	tat Tyr	atg Met 170	ggg Gly	gaa Glu	ggg Gly	aag Lys	gct Ala	gct Ala 175	gta Val	528
agt Ser	act Thr	gca Ala 180	agt Ser	cct Pro	gct Ala	gtt Val	aac Asn	tct Ser 185	gca Ala	tac Tyr	aac Asn	gca Ala	atg Met 190	atg Met	atg Met	576
att Ile	att Ile	gtt Val 195	gtt Val	gga Gly	tgg Trp	gca Ala	att Ile 200	tat Tyr	cct Pro	gct Ala	gga Gly	tat Tyr 205	gct Ala	gct Ala	ggg Gly	624
tac Tyr 210	cta Leu	atg Met	ggg Gly	ggc Gly	gaa Glu	ggg Gly 215	gta Val	tac Tyr	gct Ala	tca Ser	aac Asn 220	cta Leu	aac Asn	ctt Leu	ata Ile	672
tat Tyr 225	aac Asn	ctt Leu	gct Ala	gac Asp	ttt Phe 230	gtt Val	aac Asn	aag Lys	att Ile	cta Leu 235	ttt Phe	ggg Gly	ttg Leu	atc Ile	att Ile 240	720
tgg Trp	aat Asn	gtt Val	gct Ala	gtt Val 245	aaa Lys	gaa Glu	tct Ser	tct Ser	aat Asn 250	gct Ala						753

<210> 53

<211> 251

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 53

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
 145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
 165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
 180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
 195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
 210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
 225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 54

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PalB7; GenBank #AF349999

SECRET

SECRET

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
 180 185 190

att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt 624
 Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
 195 200 205

tac cta atg ggt ggc gaa ggt gta tac gct tca aac tta aac ctc ata 672
 Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
 210 215 220

tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att 720
 Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
 225 230 235 240

tgg aat gtt gct gtt aaa gaa tct tct aat gct 753
 Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
 245 250

<210> 55
 <211> 251
 <212> PRT
 <213> Naturally occurring gamma proteobacterium

<400> 55

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
 1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
 20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
 35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
 50 55 60

098450"ET524860

	100	105	110	
	att ctt gct gct tgt aca aat gtt gct gct tca tta ttt aag aag ctt			384
	Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu			
	115	120	125	
	cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct			432
	Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala			
	130	135	140	
	gga tta gct cct gta tgg cct gct ttc att att ggt atg gct gga tgg			480
	Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp			
	145	150	155	160
	tta tac atg att tat gag cta tat atg ggt gaa ggt aag gct gct gta			528
	Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val			
		165	170	175
	agt act gca agt cct gct gtt aac tct gca tac aac gca atg atg gtg			576
	Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val			
		180	185	190
	att att gtt gtt gga tgg gca att tat cct gct gga tat gct gct ggt			624
	Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly			
		195	200	205
	tac cta atg ggt ggc gaa ggt gta tac gct tca aac cta aac ctt ata			672
	Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile			
		210	215	220
	tat aac ctt gct gac ttt gtt aac aag att cta ttt ggt ttg atc att			720
	Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile			
		225	230	235
	tgg aat gtt gct gtt aaa gaa tct tct aat gct			753
	Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala			
		245	250	

<210> 57

<211> 251

<212> PRT

<213> Naturally occurring gamma proteobacterium

<400> 57

Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser
1 5 10 15

Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val
20 25 30

Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
50 55 60

Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
100 105 110

Ile Leu Ala Ala Cys Thr Asn Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Trp Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Val
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 58

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacteria

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PalB8; GenBank #AF350000

<400> 58

atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser	
1 5 10 15	

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt	96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val	
20 25 30	

tca	ttc	tgg	ctg	gtt	aca	gct	ggg	atg	tta	gcg	gca	act	gtg	ttc	ttt	144
Ser	Phe	Trp	Leu	Val	Thr	Ala	Gly	Met	Leu	Ala	Ala	Thr	Val	Phe	Phe	
		35					40					45				
ttt	gta	gaa	aga	gac	caa	gtc	agc	gct	aag	tgg	aaa	act	tca	ctt	act	192
Phe	Val	Glu	Arg	Asp	Gln	Val	Ser	Ala	Lys	Trp	Lys	Thr	Ser	Leu	Thr	
	50					55					60					
gta	tct	ggg	tta	att	act	ggg	ata	gct	ttt	tgg	cat	tat	ctc	tat	atg	240
Val	Ser	Gly	Leu	Ile	Thr	Gly	Ile	Ala	Phe	Trp	His	Tyr	Leu	Tyr	Met	
65					70					75					80	
aga	ggg	gtt	tgg	ata	gac	act	ggg	gat	acc	cca	aca	gta	ttc	aga	tat	288
Arg	Gly	Val	Trp	Ile	Asp	Thr	Gly	Asp	Thr	Pro	Thr	Val	Phe	Arg	Tyr	
				85					90					95		
att	gat	tgg	tta	tta	act	gtt	cca	tta	caa	atg	gtt	gag	ttc	tat	cta	336
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Gln	Met	Val	Glu	Phe	Tyr	Leu	
			100					105					110			
att	ctt	gct	gct	tgt	aca	agt	gtt	gct	gct	tca	tta	ttt	aag	aag	ctt	384
Ile	Leu	Ala	Ala	Cys	Thr	Ser	Val	Ala	Ala	Ser	Leu	Phe	Lys	Lys	Leu	
		115					120					125				
cta	gct	ggg	tca	tta	gta	atg	tta	ggg	gct	gga	ttt	gca	ggc	gaa	gct	432
Leu	Ala	Gly	Ser	Leu	Val	Met	Leu	Gly	Ala	Gly	Phe	Ala	Gly	Glu	Ala	
	130					135					140					
gga	tta	gct	cct	gta	tta	cct	gct	ttc	att	att	ggg	atg	gct	gga	tgg	480
Gly	Leu	Ala	Pro	Val	Leu	Pro	Ala	Phe	Ile	Ile	Gly	Met	Ala	Gly	Trp	
145					150					155					160	
tta	tac	atg	att	tat	gag	cta	tat	atg	ggg	gaa	ggg	aag	gct	gct	gta	528
Leu	Tyr	Met	Ile	Tyr	Glu	Leu	Tyr	Met	Gly	Glu	Gly	Lys	Ala	Ala	Val	
				165					170					175		
agt	act	gca	agt	cct	gct	gtt	aac	tct	gca	tac	aac	gca	atg	atg	atg	576
Ser	Thr	Ala	Ser	Pro	Ala	Val	Asn	Ser	Ala	Tyr	Asn	Ala	Met	Met	Met	
			180					185					190			
att	att	gtt	gtt	gga	tgg	gca	att	tat	cct	gct	gga	tat	gct	gct	ggg	624
Ile	Ile	Val	Val	Gly	Trp	Ala	Ile	Tyr	Pro	Ala	Gly	Tyr	Ala	Ala	Gly	
		195					200					205				
tac	cta	atg	ggg	ggc	gaa	ggg	gta	tac	gct	tca	aac	tta	aac	ctt	ata	672
Tyr	Leu	Met	Gly	Gly	Glu	Gly	Val	Tyr	Ala	Ser	Asn	Leu	Asn	Leu	Ile	
	210					215					220					

Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu Tyr Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
180 185 190

Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Gly Gly Glu Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
210 215 220

Tyr Asn Leu Ala Asp Leu Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 60

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacteria

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PalE1;GenBank# AF350001

<400> 60

atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser	
1 5 10 15	
ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt	96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val	
20 25 30	
tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gtg ttc ttt	144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe	
35 40 45	
ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act	192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	
gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tat atg	240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met	
65 70 75 80	
aga ggt gtt tgg ata gac act ggt gat acc cca aca gta ttc aga tat	288
Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr	
85 90 95	
att gat tgg tta tta act gtt cca tta caa gtg gtt gag ttc tat cta	336
Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Val Val Glu Phe Tyr Leu	
100 105 110	
att ctt gct gct tgt aca agt gtt gct gct tca tta ttt aag aag ctt	384
Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu	
115 120 125	
cta gct ggt tca tta gta atg tta ggt gct gga ttt gca ggc gaa gct	432
Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala	
130 135 140	
gga tta gct cct gta tta cct gct ttc att att ggt atg gct gga tgg	480

Tyr Asn Leu Ala Asp Phe Val Asn Lys Ile Leu Phe Gly Leu Ile Ile
225 230 235 240

Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

<210> 62

<211> 753

<212> DNA

<213> Naturally occurring gamma proteobacterium

<220>

<221> CDS

<222> (1)..(753)

<223> Proteorhodopsin variant from pcr clone PalE6; GenBank#AF350002

<400> 62

atg ggt aaa tta tta ctg ata tta ggt agt gct att gca ctt cca tca	48
Met Gly Lys Leu Leu Leu Ile Leu Gly Ser Ala Ile Ala Leu Pro Ser	
1 5 10 15	

ttt gct gct gct ggt ggc gat cta gat ata agt gat act gtt ggt gtt	96
Phe Ala Ala Ala Gly Gly Asp Leu Asp Ile Ser Asp Thr Val Gly Val	
20 25 30	

tca ttc tgg ctg gtt aca gct ggt atg tta gcg gca act gta ttc ttt	144
Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe	
35 40 45	

ttt gta gaa aga gac caa gtc agc gct aag tgg aaa act tca ctt act	192
Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr	
50 55 60	

gta tct ggt tta att act ggt ata gct ttt tgg cat tat ctc tac atg	240
Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met	
65 70 75 80	

aga	ggt	ggt	tgg	ata	gat	act	ggt	gat	aca	cca	aca	gta	ttt	aga	tat		288
Arg	Gly	Val	Trp	Ile	Asp	Thr	Gly	Asp	Thr	Pro	Thr	Val	Phe	Arg	Tyr		
				85					90					95			
att	gat	tgg	tta	tta	act	gtt	cca	tta	caa	atg	gtt	gag	ttc	tat	cta		336
Ile	Asp	Trp	Leu	Leu	Thr	Val	Pro	Leu	Gln	Met	Val	Glu	Phe	Tyr	Leu		
			100					105					110				
att	ctt	gct	gct	tgt	aca	agt	gtt	gct	gct	tca	tta	ttt	aag	aag	ctt		384
Ile	Leu	Ala	Ala	Cys	Thr	Ser	Val	Ala	Ala	Ser	Leu	Phe	Lys	Lys	Leu		
		115					120					125					
cta	gct	ggt	tca	tta	gta	atg	tta	ggt	gct	gga	ttt	gca	ggc	gaa	gct		432
Leu	Ala	Gly	Ser	Leu	Val	Met	Leu	Gly	Ala	Gly	Phe	Ala	Gly	Glu	Ala		
	130					135					140						
ggt	tta	gct	cct	gta	tta	cct	gct	ttc	att	att	ggt	atg	gct	gga	tgg		480
Gly	Leu	Ala	Pro	Val	Leu	Pro	Ala	Phe	Ile	Ile	Gly	Met	Ala	Gly	Trp		
145				150					155						160		
tta	tac	atg	att	tat	gag	cta	cat	atg	ggt	gaa	ggt	aag	gct	gct	gta		528
Leu	Tyr	Met	Ile	Tyr	Glu	Leu	His	Met	Gly	Glu	Gly	Lys	Ala	Ala	Val		
			165					170					175				
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Ser	Thr	Ala	Ser	Pro	Ala	Val	Asn	Ser	Ala	Tyr	Asn	Ala	Met	Met	Lys		
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Ile	Ile	Val	Ile	Gly	Trp	Ala	Ile	Tyr	Pro	Ala	Gly	Tyr	Ala	Ala	Gly		
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Tyr	Leu	Met	Ser	Gly	Asp	Gly	Val	Tyr	Ala	Ser	Asn	Leu	Asn	Leu	Ile		
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Tyr	Asn	Leu	Ala	Asp	Phe	Val	Asn	Lys	Ile	Leu	Phe	Gly	Leu	Ile	Ile		
225				230						235				240			
tgg	aat	gtt	gct	gtt	aaa	gaa	tct	tct	aat	gct							753
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<213> Naturally occurring gamma proteobacterium

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Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
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Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
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Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
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Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
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Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
130 135 140

Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
145 150 155 160

Leu Tyr Met Ile Tyr Glu Leu His Met Gly Glu Gly Lys Ala Ala Val
165 170 175

Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Lys
180 185 190

Ile Ile Val Ile Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
195 200 205

Tyr Leu Met Ser Gly Asp Gly Val Tyr Ala Ser Asn Leu Asn Leu Ile
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<223> Proteorhodopsin variant from pcr clone PalE7; GenBank# AF350003

<400> 64

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att Ile	gat Asp	tgg Trp	tta Leu 100	tta Leu	act Thr	gtt Val	cca Pro	tta Leu 105	caa Gln	atg Met	gtt Val	gag Glu	ttc Phe 110	tat Tyr	cta Leu	336
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gga Gly 145	tta Leu	gct Ala	cct Pro	gta Val 150	tta Leu	cct Pro	gct Ala	ttc Phe	att Ile 155	att Ile	ggg Gly	atg Met	gct Ala	gga Gly	tgg Trp 160	480
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agt Ser	act Thr	gca Ala 180	agt Ser	cct Pro	gct Ala	gtt Val	aac Asn	tct Ser 185	gca Ala	tac Tyr	aac Asn	gca Ala	atg Met 190	atg Met	atg Met	576
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Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
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<210> 65

<211> 251

<212> PRT

<213> Naturally occurring gamma proteobacterium

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Ser Phe Trp Leu Val Thr Ala Gly Met Leu Ala Ala Thr Val Phe Phe
35 40 45

Phe Val Glu Arg Asp Gln Val Ser Ala Lys Trp Lys Thr Ser Leu Thr
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Val Ser Gly Leu Ile Thr Gly Ile Ala Phe Trp His Tyr Leu Tyr Met
65 70 75 80

Arg Gly Val Trp Ile Asp Thr Gly Asp Thr Pro Thr Val Phe Arg Tyr
85 90 95

Ile Asp Trp Leu Leu Thr Val Pro Leu Gln Met Val Glu Phe Tyr Leu
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Ile Leu Ala Ala Cys Thr Ser Val Ala Ala Ser Leu Phe Lys Lys Leu
115 120 125

Leu Ala Gly Ser Leu Val Met Leu Gly Ala Gly Phe Ala Gly Glu Ala
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Gly Leu Ala Pro Val Leu Pro Ala Phe Ile Ile Gly Met Ala Gly Trp
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Ser Thr Ala Ser Pro Ala Val Asn Ser Ala Tyr Asn Ala Met Met Met
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Ile Ile Val Val Gly Trp Ala Ile Tyr Pro Ala Gly Tyr Ala Ala Gly
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Trp Asn Val Ala Val Lys Glu Ser Ser Asn Ala
245 250

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